

task of bringing up the arrears of the annual bulletins of meteorological observations which began and ended with the bulletin for the year 1910, published in 1914 by the former *Directoria de Meteorologia e Astronomia*. Before beginning the publication of this extensive series it was thought best to prepare the collection of normals which has just appeared. He states that the publication should be regarded as provisional in character. The observations at Rio are lacking in homo-

geneity on account of various methods of exposure and observation, and in any case it is difficult to obtain representative data for that city on account of its extremely irregular topography. The observations at field stations were taken by comparatively untrained observers in most cases. Nevertheless this publication is a noteworthy contribution to the climatology of Brazil, furnishing a more comprehensive collection of normals than has heretofore appeared for that part of the world.—C. F. T.

CONCERNING THE HALO OF 46°.

By LOUIS BESSON.

[Paris, France, June 26, 1922.]

In the MONTHLY WEATHER REVIEW of March, 1922, Professor Hastings calls the attention of meteorologists to the halo of 46°, which he believes can be explained by prisms horizontally oriented.

By a singular coincidence the Ellendale phenomenon, whose description is read just following, furnishes a positive answer on this question. If the "bright halo of 46°" observed by Mr. Ling at 11:58 a. m. had been produced by horizontal prisms this luminous arc would have been tangent to the circumzenithal arc instead of being separated from it by a distance of 4° or 5°.

Relative to this may I be permitted to recall that on December 21, 1910,¹ I observed a circumzenithal arc not touching the halo of 46°, and that my associate M. Dutheil observed on February 18, 1912, a short arc 3° above the large halo.²

It is very rare that the nonoriented prisms by adding in this way their effect to that of the others reveal their existence in a manner so characteristic, but there are seen rather frequently halos of 46° that have so manifestly the form of a perfect circle that they could be attributed only to such prisms. I could cite rather numerous examples in our observations at Montsouris.

Professor Hastings objects that the halo of 46° appears only when the sun is not too high. I gave, in 1909, in my memoir on the theory of halos³ figures that indicate in effect that the phenomenon presents a very decided maximum of frequency for a solar elevation of near 20°. What does that prove? Simply that the prisms that produce it have a tendency to orient themselves and that their balancings are of limited amplitude.

It is about the vertical that these balancings appear to be executed. To simplify, let us consider only the highest point of the halo of 46°. It is readily seen that if the sun is at 22° 8' elevation innumerable vertical prisms are effective. If the sun is 10° higher or lower, that is to say at 32° 8' or at 12° 8', it would be necessary that the prisms incline 10° in one direction or in the other. If the sun is at 42° 8' or at 2° 8' balancings of 20° will be necessary.

I shall add that the prisms whose axes oscillate about the horizontal contribute to the production of the halo of 46° when the sun is slightly elevated, but they bring forth especially the lateral parts, while the prisms near the vertical give the upper part.

Most often, but not always, the persistent existence of the maximum of intensity, whether above or at the side, betrays the tendency of the generating crystals toward a definite orientation. This remark is not peculiar to the halo of 46°. It is true also of the halo of 22°, for all

observers know that of it there is seen especially the culminating part or the segments at the elevation of the sun.

It can happen that there is taken for an arc of the halo of 46° a supralateral tangent arc or an arc bitangent to this halo, the coloring being of the same order as that of the halo, from which they are usually difficult to distinguish.

At Montsouris in the first years we sometimes must have made this error, all the more pardonable in that there was not yet certainty as to the real existence of these tangential arcs foreseen by the intuition of Bravais. However, their reality is no longer in doubt, and we have learned to recognize them rather well even when they are very short by their colors, which are more vivid than those of the halo of 46°, and by the accompanying appearance of the tangential arc of 22°. The possibility of a mistake in this regard does not preclude the fact that just as there is a halo of 22° there is also a circular halo of 46° produced by prisms of 90°, whose position is near that of the minimum of deviation in accord with the old explanation by Cavendish.

I find in my notes figures showing under what conditions there appeared 79 halos of 46° observed at Montsouris from 1898 to 1908. It is, perhaps, not without interest to reproduce them here.

Phenomena visible at the same time as the halo of 46° or a little previous.

	Per cent.
Halo of 22°, not brilliant, alone.....	30
Halo of 22°, brilliant, or rather brilliant, alone.....	27
Parhelia.....	13
Tangential arcs of 22°, with parhelia.....	11
Tangential arcs of 22°, without parhelia.....	11
No phenomena.....	5
No definite indications.....	3

When the halo of 46° accompanies a halo of 22° that is brilliant and uniformly so, it may be asked if it is not produced "secondarily" by two successive refractions in prisms of 60°. Its radius would then be 44°. Among our numerous measurements there were three that gave this result, but correctness was not certain.

This is a point to which I take the liberty of directing the attention of observers.

TORNADOES IN WISCONSIN.

By W. P. STEWART, Meteorologist.

[Weather Bureau, Milwaukee, Wis.]

June 15, 1922.—During the evening of June 15, 1922, a destructive thunder squall and tornado swept over parts of four counties in northwestern Wisconsin, causing the loss of eight lives, injuries to about 100 persons, and property damage estimated at \$500,000.

¹ *Annales de l'Observatoire de Montsouris*. Tome XI, p. 47.

² *Loc. cit.* Tome XII, p. 241.

³ *Loc. cit.* Tome X, p. 186.